services can be utilized. An exemplary efficient coding scheme for data is disclosed in U.S. Patent No. 5,933,426, entitled "SOFT DECISION OUTPUT DECODER FOR DECODING CONVOLUTIONALLY ENCODED CODEWORDS", filed November 6, 1996, issued August 3, 1999, assigned to the assignee of the present invention and incorporated by reference herein.

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Page 4, line 7, first full paragraph:

The C/I achieved by any given user is a function of the path loss, which for terrestrial cellular systems increases as r^3 to r^5, where r is the distance to the radiating source. Furthermore, the path loss is subject to random variations due to man-made or natural obstructions within the path of the radio wave. These random variations are typically modeled as a log normal shadowing random process with a standard deviation of 8 dB.

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Page 4, line 16, second full paragraph:

The obtained C/I distribution can only be achieved if, at any instant in time and at any location, the subscriber station is served by the best base station which is defined as that achieving the largest C/I value, regardless of the physical distance to each base station. Because of the random nature of the path loss as described above, the signal with the largest C/I is not always transmitted by the base station closest to the subscriber station. In contrast, if a subscriber station was to communicate only via the base station of minimum distance, the C/I can be substantially degraded. It is therefore beneficial for subscriber stations to communicate to and from the best serving base station at all times, thereby achieving the optimum C/I value. It can also be observed that the range of values of the achieved C/I, in the above idealized model, is such that the difference between the highest and lowest value can be as large as 10,000. In practical implementation the range is typically limited to approximately 1:100 or 20 dB. It is therefore possible for a CDMA base station to serve subscriber stations with information bit rates that can vary by as much as a factor of 100, since the following relationship holds:

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$$R_b = W\frac{(C/I)}{(E_b/I_o)}, \tag{1}$$

where R_b represents the information rate to a particular subscriber station, W is the total bandwidth occupied by the spread spectrum signal, and E_b/I_o is the energy per bit over interference density required to achieve a given level of performance. For instance, if the spread spectrum signal occupies a bandwidth W of 1.2288 MHz and reliable communication requires an average E_b/I_o equal to 3 dB, then a subscriber station which achieves a C/I value of 3 dB to the best base station can communicate at a data rate as high as 1.2288 Mbps. On the other hand, if a subscriber station is subject to substantial interference from adjacent base stations and can only achieve a C/I of -7 dB, reliable communication cannot be supported at a rate greater than 122.88 Kbps. A communication system designed to optimize the average throughput will therefore attempts to serve each remote user from the best serving base station and at the highest data rate R_b which the remote user can reliably support. The data communication system of the present invention exploits the characteristic cited above and optimizes the data throughput from the CDMA base stations to the subscriber stations.

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Page 5, line 17, first full paragraph:

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The present invention resides in a communication system, apparatus, and method for performing handoff in a wireless communication system, which takes into account the ability of a base station to receive the reverse link transmissions from the subscriber station.

Page 6, line 14, second full paragraph:

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In an alternative embodiment, the subscriber station stores the power control commands from each base station. In a second alternative embodiment, the subscriber station stores an indication of the number of consecutive or nearly consecutive requests

a6 cont

to increase transmission energy from each base station. A series of requests to increase transmission energy indicates that the base station is not receiving the reverse link signal.

Page 6, line 32, fifth full paragraph:

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If the selected base station does require a handoff, then the subscriber uses the method of the present invention to determine if the selected base station is receiving its reverse link transmissions. In the exemplary embodiment, the subscriber station makes this determination by looking at the history of reverse link power control commands transmitted by the selected base station. A sufficient number of power control commands by a given base station requesting the subscriber station to decrease its transmission energy indicates that the reverse link signal is being received by the base station with sufficient energy. It will be understood that other methods of performing this analysis are equally applicable, for example the base stations could intermittently transmit a message indicating the average quality of the received reverse link signal.

Page 7, line 37, fifth full paragraph:

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The features, objects, and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. 1 is a flowchart illustrating an exemplary method of performing a handoff;

FIG. 2 is a basic diagram illustrating an exemplary embodiment of a communication system;

FIGS. 3A and 3B is a block diagram illustrating an exemplary embodiment of a base station;

FIGS. 4A and 4B are diagrams illustrating an exemplary embodiment of a frame structure and slot structure; and

FIG. 5 is a block diagram illustrating an exemplary embodiment of a subscriber station.

Page 9, line 18, third full paragraph:

If the selected base station does require a handoff, then the process moves to block 108. In block, 108, the subscriber determines if the selected base station is receiving its reverse link transmissions. In the exemplary embodiment, the subscriber station makes this determination by looking at the history of reverse link power control commands transmitted by the selected base station. A sufficient number of power control commands requesting the subscriber station to decrease its transmission energy is indicative that the signal strength of its reverse link transmissions are being received by the selected base station. It will be understood that other methods of performing this analysis are equally applicable, for example the base stations could intermittently transmit a message indicating the average quality of the received reverse link signal. Furthermore, the busy tones, as described below, can be used to determine the quality of the reverse link.

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Page 10, line 28, fourth full paragraph:

Referring to the figures, FIG. 2 represents an exemplary embodiment of a data communication system comprising multiple cells 200a-200f. Each cell 200 is serviced by a corresponding base station 202 or base station 204. Base stations 202 are base stations that are in active communication with subscriber station 206 and are said to make up the active set of subscriber station 206. Base stations 204 are not in communication with subscriber station 206 but have signals with sufficient strength to be monitored by subscriber station 206 for addition to the active set if the strength of the received signals increases due to a change in the propagation path characteristics. Base stations 204 are said to make up the candidate set of subscriber station 206.

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Page 11, line 14, first full paragraph:

A block diagram of an exemplary embodiment of a base station is shown in FIGS. 3A and 3B. The data is partitioned into data packets and provided to CRC encoder 312. For each data packet, CRC encoder 312 generates frame check bits (e.g., the CRC parity bits) and inserts the code tail bits. The formatted packet from

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CRC encoder 312 comprises the data, the frame check and code tail bits, and other overhead bits which are described below. The formatted packet is provided to encoder 314 which, in the exemplary embodiment, encodes the data in accordance with a convolutional or turbo encoding format. The encoded packet from encoder 314 is provided to interleaver 316 which reorders the code symbols in the packet. The interleaved packet is provided to frame puncture element 318 which removes a fraction of the packet in the manner described below. The punctured packet is provided to multiplier 320 which scrambles the data with the scrambling sequence from scrambler 322. The output from multiplier 320 comprises the scrambled packet. The scrambled packet is provided to variable rate controller 330 which demultiplexes the packet into K parallel in-phase and quadrature-phase channels, where K is dependent on the data rate. In the exemplary embodiment, the scrambled packet is first demultiplexed into the in-phase (I) and quadrature-phase (Q) streams. In the exemplary embodiment, the I stream comprises even indexed symbols and the Q stream comprises odd indexed symbol.

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Page 12, line 13, second full paragraph:

In addition, a forward activity bit is provided to symbol repeater 350. The forward activity bit alerts subscriber station 206 to a forthcoming blank frame in which the base station will not transmit forward link data. This transmission is made in order to allow subscriber station 206 to make a better estimate of the C/I of the signal from base stations 202. The repeated versions of the forward activity bit are Walsh covered in Walsh cover element 352 so as to be orthogonal to the Walsh covered power control bits. The covered bits are provided to gain element 354 which scales the bits prior to modulation so as to maintain a constant total transmit power.

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Page 12, line 22, third full paragraph:

In addition, a busy tone is provided to symbol repeater 350. The busy tone alerts subscriber station 206 to a reverse link loading condition. In an exemplary embodiment, the busy tone is a single bit indicative of the reverse link being fully loaded

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or having capacity. In the preferred embodiment, the busy tone is a two bit signal indicative of a request by base station 202 for subscriber stations 206 in its coverage area to either deterministically increase or decrease the rate of their reverse link transmissions, or to stochastically increase or decrease the rate of their reverse link transmissions. The repeated versions of the busy tone is Walsh covered in Walsh cover element 352 so as to be orthogonal to the Walsh covered power control bits and forward activity bit. The covered bit is provided to gain element 354 which scales the bits prior to modulation so as to maintain a constant total transmit power.

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Page 12, line 34, fourth full paragraph:

The pilot data comprises a sequence of all zeros (or all ones) which is provided to multiplier 356. Multiplier 356 covers the pilot data with Walsh code W0. Since Walsh code W0 is a sequence of all zeros, the output of multiplier 356 is the pilot data. The pilot data is time multiplexed by MUX 362 and provided to the I Walsh channel which is spread by the short PNI code within complex multiplier 366 (see FIG. 3B). In the exemplary embodiment, the pilot data is not spread with the long PN code, which is gated off during the pilot burst by MUX 376, to allow reception by all subscriber stations 206. The pilot signal is thus an unmodulated BPSK signal.

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Page 13, line 24, second full paragraph:

In the exemplary embodiment, the data packet is spread with the long PN code and the short PN codes. The long PN code scrambles the packet such that only the subscriber station 206 for which the packet is destined is able to descramble the packet. In the exemplary embodiment, the pilot and power control bits and the control channel packet are spread with the short PN codes but not the long PN code to allow all subscriber stations 206 to receive these bits. The long PN sequence is generated by long code generator 374 and provided to multiplexer (MUX) 376. The long PN mask determines the offset of the long PN sequence and is uniquely assigned to the destination subscriber station 206. The output from MUX 376 is the long PN sequence during the data portion of the transmission and zero otherwise (e.g. during the pilot and

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power control portion). The gated long PN sequence from MUX 376 and the short PNI and PNQ sequences from short code generator 380 are provided to multipliers 378a and 378b, respectively, which multiply the two sets of sequences to form the PN_I and PN_Q signals, respectively. The PN_I and PN_Q signals are provided to complex multiplier 366.

Page 14, line 4, first full paragraph:

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The block diagram of the exemplary embodiment of the base station shown in FIGS. 3A and 3B is one of numerous architectures which support data encoding and modulation on the forward link. Other architectures, such as the architecture for the forward link traffic channel in the CDMA system which conforms to the IS-95 standard, can also be utilized and are within the scope of the present invention.

Page 14, line 13, second full paragraph:

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A diagram of an exemplary embodiment of a forward link frame structure is illustrated in FIG. 4A. The traffic channel transmission is partitioned into frames which, in the exemplary embodiment, are defined as the length of the short PN sequences or 26.67 msec. Each frame can carry control channel information addressed to all subscriber stations 206 (control channel frame), traffic data addressed to a particular subscriber station 206 traffic frame), or can be empty (idle frame). The content of each frame is determined by the scheduling performed by the transmitting base station 202. In the exemplary embodiment, each frame comprises 16 time slots, with each time slot having a duration of 1.667 msec. A time slot of 1.667 msec is adequate to enable subscriber station 206 to perform the C/I measurement of the forward link signal. A time slot of 1.667 msec also represents a sufficient amount of time for efficient packet data transmission.

Page 14, line 30, fourth full paragraph:

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An exemplary diagram of the forward link slot structure is shown in FIG. 4B. In the exemplary embodiment, each slot comprises three of the four time multiplexed channels, the traffic channel, the control channel, the pilot channel, and the overhead

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control channel. In the exemplary embodiment, the pilot signal is transmitted in two bursts and the overhead control channel is transmitted on either side of the second pilot burst. The traffic data is carried in three portions of the slot (402a, 402b and 402c).

Page 15, line 6, first full paragraph:

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FIG. 5 illustrates an exemplary embodiment of the subscriber station 206. Forward link signals are received at antenna 500 and provided through duplexer 502 to receiver 504. In the exemplary embodiment, receiver 504 is a quaternary phase shift keying (QPSK) receiver. It will be understood by one skilled in the art that the present invention is equally applicable to any other modulation format such as BPSK or QAM.

Page 15, line 12, second full paragraph:

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The in-phase and quadrature-phase components of the received signal are provided to PN despreaders 506. In the exemplary embodiment, multiple PN despreaders 506A-506N are provided. Each of despreaders 506 is capable of demodulating a signal from a different base station in the Active set of subscriber station 206 or a different multipath component of the signal from a base station.

Page 15, line 18, third full paragraph:

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The PN despread signal is provided to power control command (PCC) demodulator 508. In the exemplary embodiment, PCC demodulator 508 performs an FHT on the received power control symbols and determines whether the base station is requesting subscriber station 206 to increase or decrease its transmission energy.

Page 15, line 23, fourth full paragraph:

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The demodulated power control symbols are provided to power control command combiner 516. In the exemplary embodiment, power control command combiner 516 soft combines multipath components of the power control command symbols from a single base station and generates a hard estimate of the power control command from each base station. The hard estimate from each of the base stations is

a22 cont stored in memory 518. In an alternative embodiment, a statistic representing the recent history of power control commands from each base station is stored in memory 518.

Page 15, line 31, fifth full paragraph:

a23 Then, power control command combiner 516 performs an OR-of-the-downs operation in which the transmission energy of subscriber station 206 is only increased if all the power control commands indicate a need to increase the transmission energy. Power control command combiner 516 provides a control signal to transmitter (TMTR) 528 increasing or decreasing its amplification of the reverse link signal from subscriber station 206.

Page 16, line 7, first full paragraph:

a24 Control Processor 520 sums the energies from multipath components of a common base station and generates and chip energy to interference ratio for each base station. Control processor 520 then selects the base station with the highest (C/I) and selects a requested rate for that base station. After the base station is selected, the operation described in blocks 106-118 of FIG. 1 is performed by control processor 520.

Page 16, line 23, third full paragraph:

a25 Transmitter 528 upconverts, amplifies, and filters the signal for transmission. In the exemplary embodiment, transmitter 528 also spreads the reverse link signal in accordance with a pseudonoise sequence. The signal is provided through duplexer 502 for transmission through antenna 500.